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Temperature of Metallic Objects in Space

1p.

The report by C. Butler and R. Jenkins (1) on "Temperature of an iron meteoroid in space" shows an application of thermodynamic theory similar to that used some 6 years ago to predict the solar heating of artificial satellites (2). Their report generally agrees with the theory (later confirmed by actual measurements on satellites) thus previously developed for temperatures of a solid body in space and in full sunlight. However, they have neglected the factor, for bodies near the earth, of the shadow of the earth. Consideration of this neglected factor would seem to modify very seriously their categorical conclusions that "the equilibrium temperature of an iron meteoroid just before entering the earth's atmosphere will be close to 90°C," and that any assumptions that meteoroids are "quite cold" just before entering the atmosphere necessarily contradict thermodynamic theory.

If a meteoroid enters the earth's atmosphere at night (and such is the case for the vast majority for which the fall is *observed*), it seems obvious that it has not been at equilibrium temperature in sunlight for at least the previous few minutes. Satellites moving across the 12,700-km diameter of the earth's shadow are ordinarily in darkness for up to an hour or more, and meteoroids in eccentric heliocentric orbits, which might traverse a good part of the nearly 1½-million-km length of the umbral cone, would seem liable to much longer eclipses, in spite of their higher relative velocity. Also, there is much greater length and volume of the penumbral cone within which the decreased solar-radiation flux would lower the equilibrium temperature 50°C or more. For a meteoroid whose orbit has been determined, the duration of its pre-entry eclipse could be computed.

Butler and Jenkins's formula shows the equilibrium time of an iron meteoroid 20 cm in diameter, weighing some 20 kg, to be about half an hour. Actual measurements on metallic objects in outer space, such as the artificial satellite Explorer IV, have shown the surface temperature to drop from +50°C to -20°C in about the same length of time in the earth's shadow (3). This observation is only a more close-up confirmation of effects noted many years ago on our natural moon. Pettit (4) at the Mount Wilson Observatory found that the temperatures of certain areas on the moon, as indicated by their infrared radiation, fell as rapidly as 150°C per hour during a lunar eclipse. Hence I would see no reason to question the authenticity of reports such as that quoted by C. A. Young (5), "that one of the large fragments of the Dhurmsala (India) meteorite, which fell in 1860, was found in moist earth half an hour or so after the fall, *coated with ice.*"

My conclusion would be that, in general, the temperature of an iron meteoroid just before entering the earth's atmosphere may be anywhere from about 90°C down to much below the freezing point of water, depending upon its size and the duration of its preceding eclipse in the earth's shadow.

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References

1. C. P. Butler and R. J. Jenkins, *Science* **142**, 1567 (1963).
2. R. H. Wilson, Jr., *ibid.* **127**, 811 (1958); **128**, 208 (1958).
3. G. Heller, *Am. Rocket Soc. J.* **31**, 344 (1960).
4. E. Pettit, *Astrophys. J.* **91**, 408 (1940).
5. C. A. Young, *General Astronomy* (Ginn, Boston, 1891), p. 435.

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